lattice if the metal is pure. Obviously, the composition of this layer will depend upon that of the bulk of the liquid and upon the affinities of the iron ions for the nitric acid and the water. We may regard the nitric acid as ionised, but not so the water, because its ionisation is known not to be increased by the presence of dissolved electrolytes. Owing to the symmetry of the water molecule, it is impossible to say which H atom will break away and which will remain in the OH group in the event of ionisation.

Now it is highly probable that the chemical force, between ions even, is not wholly electrical, and we may assume that the nitrate ion and the water molecule will be attracted to their respective iron ions with forces which result in the setting up of an e.m.f. in the metal. If this e.m.f. is large enough, one of the metal ions will be discharged into the liquid momentarily as ferric nitrate, and in the model the atoms marked (*a*) will form water, the remaining H will be momentarily liberated, and positive current will flow as indicated by the arrows.

Two factors will make for passivity: a low electrode potential and homogeneity of the double layer above AB. Impurities in the metal will modify its electrode potential as well as the composition of the double layer. We find passivity a common property of the noble metals almost irrespective of the composition of the double layer, whereas with highly positive (active) metals passivity is never observed. In the case of intermediate metals passivity occurs only with certain kinds of double layers, and if these are unstable periodic action may result. Since the forces are not wholly electrical there is less chance for an electrostatic equilibrium—and consequent passivity—to be set up, and for this reason it seldom occurs with these metals.

A sufficient disturbance of the surface layer, by scratching, touching with a more electro-positive metal such as zinc, placing in a magnetic field, or heating, will, in conformity with experience, activate passive iron. It is significant that Smits and Lobry de Bruyn (Proc. K. Akad. Wetensch. Amsterdam, vol. xxi., p. 382, 1919) find that chlorine ions activate anodically polarised iron. Thus it seems that iron ions in the surface of the metal have a preferential affinity for Cl' over NO_3'. W. HUGHES.

Bedford Modern School, January 10.

The Space-Time Hypothesis before Minkowski.

IT is, perhaps, not generally realised that the theory of space and time, to which Minkowski was led on experimental grounds, had been formulated on general principles sixty-five years previously by Hamilton, the Irish mathematician. The point is, however, of interest, not merely as a question of priority, but for the insight it affords into the philosophic basis of the theory, as well as for the useful mathematical methods it suggests.

It is curious, therefore, that there should be a lack of recognition that the world of Minkowski is in all points identical with the system of quaternions of Hamilton, and that the latter mathematician specifically regarded this system as a four-dimensional expression of space and time, in which space bears to time the relation which $\sqrt{-1}$ bears to unity, time being the scalar part of the quaternion.

Quotations may be given from Hamilton's letters and manuscripts, cited in his "Life" by Graves, which leave no doubt on this matter.

Thus, vol. ii., p. 478:

"Let me suggest one leading thought, which will perhaps sound paradoxical, that time and space are imaginary, each with respect to the other. . . . Any expression for the peculiar relations of space in the forms of time, or for those of time in the forms of space, must therefore involve a seeming contradiction . . . it will be a 'mathematical imaginary.' This seems to me to be the clue, the secret of the matter."

Vol. iii., p. 635:

"The mathematical quaternion . . . in technical language may be said to be 'time *plus* space,' or 'space *plus* time,' and in this sense it has, or at least it involves a reference to, four dimensions."

In another place:

"My real is a kind of fourth dimension equally inclined to all directions of space."

Many other allusions will be found which prove that this idea was fundamental in the views of Hamilton, and that he held to it with the greatest tenacity, although there were at that period no experimental considerations to justify it, and although De Morgan and other mathematicians seem to have discouraged it, or ridiculed it. At the same time it does not appear that Hamilton has given an analysis of space and time which exhibits with sufficient clearness the concept of direction in space as being peculiarly attached to the symbol $\sqrt{-1}$, and the concept of positive and negative unity as being similarly connected with the two directions of time, towards the future and the past.

It is, however, easy to supply such an analysis, the clue being given by noting that to define a number by the equation $x^2+1=0$ virtually defines it as "a unit which cannot be differentiated from its own negative by any *qualitative* distinction."

It indeed appears to have been in the thought of Hamilton, as it must occur to anyone who considers the matter, that the connection between a root of the equation $x^2+1=0$ and a direction of space is to be looked upon as more than a mere symbolism; but the general philosophic bearing of such considerations on the whole nature of space and time is scarcely appropriate for discussion here. It may, however, be remarked that they indicate a point of view in which time and three-dimensional Euclidean space lose their apparently contingent character, and approach the necessity of the laws of arithmetic, of which they appear as a kind of derivative.

It should be added that practical advantage might be derived by mathematicians from the application of the methods of quaternions to the theory of relativity, for, besides offering a convenient mode of development of the geometry of four dimensions, either Euclidean or hyperbolic, according as Tq or $\sqrt{Sq^2}$ is taken as the element of length, they suggest important possibilities in connection with the inversion of a linear quaternion function analogous to the physical applications by Tait of the linear vector function. E. H. SYNGE.

Dublin, January 6.

Heredity and Acquired Characters.

WILL you permit a statement from a humble student? Between twenty-two and twenty-seven years ago, while in Malabar, opportunity was taken by me to ascertain whether the arms of rowers on the backwaters and the arms of the toddy-drawers were longer in proportion to the height than in the case of the rest of the population, for here seemed to offer a test whether "inheritance of the effects of use" was evident. In both cases the men belonged to a caste which had not changed its occupation for many hundreds, perhaps some thousands, of years: the former indigenous, while legend attributed the ancient home of the latter to Ceylon, where they were occupied in the same way—climbing and tapping the palm-trees

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for toddy. The stretch of arms in rowing demands no explanation, but it may be mentioned that the rowers were not engaged in rowing as they might be in England, but often continuously for long periods. Thus on first acquaintance they rowed (eighteen of them) forty-six miles to where I was, halted an hour or so to cook and eat a meal, and rowed back again the same distance, covering the ninety-two miles within twenty-four hours—not at all as a feat, but just in the ordinary way of work.

The climbing of the palms in this region needs some remarks, because whereas toddy-drawers are usually sustained by a strap round the back to ease the strain on the arms, in Malabar the whole weight of the body is borne by the arms alone, legs straight, feet held together by a grummet, the hands embracing the stem. Climbing in this manner is fatiguing, and when he has reached the top the climber works for about a quarter of an hour preparing the spathe, changing his pots, and so on, all the while upheld by the arms, which are thus on the stretch for a considerable portion of each day. It seemed, therefore, worth while to examine by careful measurements with instruments for anthropological work whether the continual straining of the arms during many generations affected the length of arms in relation to length of body-height. The result was that it did not. The arms of the hereditary rowers and of the hereditary climbers are no longer in proportion to height than of those engaged in occupations involving no strain of the arms. Writing far from home, I am unable to give you measures. Frederick Fawcett.

Algiers, January 12.

Popular Science Lectures on Natural History.

The lectures to juveniles at the Royal Institution by Prof. J. Arthur Thomson have been undoubtedly a great success, and I cannot help thinking that there are others, especially among our young men fresh from the universities, who could give lectures of this kind to popular audiences. If so, can they be discovered? They may be difficult to find, for success in this field requires a rare combination of gifts. It is absolutely necessary for such a lecturer to possess, besides knowledge and enthusiasm, a good voice and manner; his speech must be fairly loud, good, and clear, and his personality distinctly pleasing, or he will fail to win his audience. Unfortunately, few scientific men are good public speakers. It is also much to be regretted that many writers on biology and natural history adopt a style so learned and pedantic that both young and old are repelled.

Huxley, the younger Buckland, Gosse, and Hugh Miller are gone, and few follow in their steps. How sadly are the themes of beauty, mutual aid (so well treated by Kropotkin), and symbiosis neglected by modern writers! Those who do treat of these subjects seem to deal with them in a cold, dry way. The leading idea in Prof. Thomson's lectures is conquest by animals of the elements, and no other lecturer or writer has developed the subject as Prof. Thomson has done.

In conclusion, may I ask whether it would be possible to arrange courses of lectures on the same lines in different parts of London? It seems a pity that such lectures should be confined to the Royal Institution. Eager South London audiences can be found for Shakespeare's plays, and I believe good lectures on natural history would also appeal to such audiences, especially if well illustrated and well delivered.

H. Neville Hutchinson.

Royal Societies' Club, January 10.

Anglo-American University Library for Central Europe.

In connection with the above library, we are endeavouring to supply the various university libraries on the Continent with the scientific journals they urgently need.

Among the periodicals for which we have received a pressing demand Nature is frequently mentioned, and I very much hope that you will be good enough to publish this letter in your columns so that any of your readers having copies of your journal from 1914 onwards may hear of our appeal. Any numbers of the periodical which readers may feel they can dispense with will be gratefully welcomed.

The library is entirely non-political and non-sectarian, its sole object being to enable humanity at large to benefit in the future, as it has done in the past, from the research of European scholars. Such research has been brought almost to a standstill from the fact that European centres of learning have been cut off since 1914, first of all by the blockade, and more recently by the exceedingly unfavourable position of the foreign exchanges, from English and American thought.

I fervently hope that some of your readers may be able to help in supplying the literary needs of Central Europe. A copy of the prospectus of the library will be gladly sent to anyone desiring a fuller account of its work and objects. B. M. Headicar,

Hon. Secretary.

London School of Economics, Clare Market,
London, W.C.2, January 21.

Greenland in Europe.

Whatever lapse may be imputed to the London school-book of 1812, noticed by Mr. MacRitchie in Nature of January 13, p. 647, it is not shared by the Rev. J. Goldsmith's "Geography, on a Popular Plan, Designed for the Use of Schools, and Young Persons," in its fifth edition at the earlier date of 1808. For that author, in a very interesting account of Greenland, at p. 46 remarks that many so-called "ice islands" "are to be met with on the coasts of Spitzbergen, to the great danger of the shipping employed in the Greenland fishery." He further instances the peril to which "Lord Mulgrave" was thus exposed in 1772, when by an opportune rising of the wind his ships, "after labouring against the resisting fields of ice, arrived at the west end of Spitzbergen." At this critical time, however, "Lord Mulgrave" was Capt. Phipps. T. R. R. S.

January 20.

Electric Light and Vegetation.

Mr. Pendred's interesting observations on the growth of vegetation beside the electric lights in the Cheddar caves (Nature, vol. cv., p. 709, August 5, 1920) reminds me of some observations described by Mr. E. Cheel in the *Australian Naturalist*, vol. ii., 1912, p. 117. Of a number of plane-trees growing about Sydney railway station some were close to the large electric lights, and Mr. Cheel noticed that the branches nearest the lights retained their leaves from a month to a month and a half longer than the more distant branches of the same tree and than the trees distant from the lights. When the new leaves were opening in spring a similar period elapsed between the dates of opening of those near the lights and those distant therefrom, the branches subject to illumination being that much later in getting their leaves. Thos. Steel.

Sydney, New South Wales.

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